

*A COMPREHENSIVE ANALYSIS OF
INFRASTRUCTURE LINKAGES AND
MULTIPLIERS FOR AUSTRALIA*



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This dissertation is submitted in partial fulfilment of the requirements for
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Dedicated to

My Beautiful Wife,

My Wonderful Children

and

My Dearest Grandson Koa Julian

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CERTIFICATE OF AUTHORSHIP/ ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree, nor has it been submitted as part of the requirements for a degree, except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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CONTENTS

CERTIFICATE OF AUTHENTICITY	v
ACKNOWLEDGEMENT	vii
TABLE OF CONTENTS.....	ix
LIST OF TABLES	xii
LIST OF FIGURES.....	xv
LIST OF ABBREVIATIONS	xviii
LIST OF APPENDICES	xxiii
ABSTRACT	xxv
1 INTRODUCTION.....	1
1.1 Background.....	1
1.2 Infrastructure: A national priority	1
1.3 Future infrastructure challenges.....	3
1.4 Infrastructure linkages and multipliers.....	5
1.5 Summary of the existing studies	5
1.6 Research objectives.....	7
1.7 Research methodological framework.....	8
1.8 Research scope	11
1.9 Data consideration.....	12
1.10 Significance of this research	15
1.11 Thesis structure	17
2 IMPORTANCE OF INFRASTRUCTURE IN AUSTRALIA	19
2.1 The importance of infrastructure in the global context.....	19
2.2 The importance of infrastructure in the Australian context	20
2.3 Major indicators for measuring importance of infrastructure	22
2.4 Infrastructure spending in Australia.....	25
2.4.1 <i>Public infrastructure spending</i>	27
2.4.2 <i>Private infrastructure spending</i>	30
2.4.3 <i>Total infrastructure spending</i>	33
2.4.4 <i>Infrastructure grouping vs sources of investment</i>	34
2.5 Linkage of infrastructure with economic growth.....	35
2.6 Infrastructure-economy linkages: A GDP model.....	38
2.7 Summary	44
3 HISTORICAL PROFILE OF INFRASTRUCTURE IN AUSTRALIA.....	47
3.1 Historical profile of infrastructure in Australia.....	47
3.1.1 <i>Water infrastructure</i>	47
3.1.2 <i>Coal infrastructure</i>	53
3.1.3 <i>Gas infrastructure</i>	58
3.1.4 <i>Oil infrastructure</i>	61
3.1.5 <i>Electricity infrastructure</i>	65
3.2 Infrastructure linkages - upstream, transportation and downstream	70
3.3 Main Points	82

4 A FRAWORK FOR QUANTITATIVE ANALYSIS	89
4.1 Review of analytical methods.....	89
4.2 Shortcomings of the existing methods.....	98
4.3 Analytical framework for this research	101
4.3.1 Gaps addressed by the <i>IeIOM</i>	106
4.3.2 Incorporation of un-weighted and weighed methodologies	108
4.3.3 Balancing of <i>IeIoT</i> and testing the model.....	108
4.3.4 Mathematical formulation of the <i>IeIOM</i>	109
4.3.5 The linkages analytic module	112
4.3.6 Measurements of linkages	115
4.3.7 Elasticity analysis	123
4.3.8 Final demand transformation of economic activity.....	124
4.3.9 Analysis of multipliers	125
4.4 Key features of the methods	129
5 SYSTEM OF WEIGHTS: ALTERNATIVE CONCEPTIONS	133
5.1 Overview	133
5.2 Current system of weights	134
5.2.1 Equally-Weighted System of Weights (<i>ESOW</i>)	134
5.2.2 Weighted System of Weights (<i>WSOW</i>).....	136
5.2.3 Alternative approaches for assigning weights.....	139
5.2.4 Selection of a system of weights.....	142
5.3 Proposed system of weights	143
5.3.1 Sectoral weights: existing and proposed formulation	143
5.3.2 Weighting coefficients: existing and proposed formulation	144
5.3.3 Coefficient of variation: existing and proposed formulations	153
5.3.4 Weighted key sectors	160
5.4 Comparison of traditional and proposed methods	161
5.5 Summary and key features of the methods.....	167
6 RELATIVE IMPORTANCE OF IO COEFFICIENTS	169
6.1 Relative contribution to GVA.....	169
6.2 Most Important Coefficients (MIC) of supply and production sectors.....	173
6.2.1 The purpose of MICs and sensitivity analysis in general.....	173
6.2.2 Interpretation of MICs	173
6.2.3 Number of MICs and impact on sectoral linkages.....	174
6.2.4 Sectors associated with MICs	177
6.2.5 Stability of the MICs and other coefficient classes	182
6.3 Sector interconnectedness: concentration and entropy indices.....	184
6.3.1 Backward and forward concentration indices	184
6.3.2 Backward and forward entropy indices	189
6.4 Summary of the key findings.....	192
7 IO FOUR-QUADRANT LINKAGES ANALYSIS FRAMEWORK.....	197
7.1 Introduction	197
7.2 Inter-industry sectoral linkages.....	200
7.3 Primary factors total linkages (PF).....	222

7.4 Final demand total linkages	229
7.5 Linkages of final demand sectors with primary factors	234
7.6 A Proposed Sectoral Classification System (SCS)	236
7.7 Summary of key findings	241
8 MULTIPLIERS, ELASTICITY, AND FINAL DEMAND	247
8.1 Multipliers.....	247
8.1.1 <i>Output multipliers</i>	247
8.1.2 <i>Employment multipliers</i>	256
8.1.3 <i>Income multipliers</i>	260
8.1.4 <i>Value added multipliers</i>	266
8.1.5 <i>Multiplier relationships and policy impacts</i>	271
8.2 Linkage elasticities.....	273
8.2.1 <i>Elasticity of Sectoral Supply Response (ESSR)</i>	273
8.2.2 <i>Elasticity of Sectoral Final Demand-Value Added (FD-VA) Response</i>	277
8.2.3 <i>Policy implication of elasticity measurements</i>	281
8.3 Linkages by final demand transformation approach	282
8.4 Summary of key findings	287
9 LINKAGES: SCENARIO ANALYSIS (2015-2050).....	291
9.1 National Energy Guarantee (NEG) Scheme	291
9.2 Future scenarios	291
9.3 Scenario results, 2015 to 2050	298
9.3.1 <i>Backward linkages</i>	298
9.3.3 <i>Forward linkages</i>	307
9.3.3 <i>Key sectors</i>	316
9.3.4 <i>Economy-wide impacts</i>	321
9.4 Conclusions.....	323
10 CONCLUSIONS , CONTRIBUTIONS, RECOMMENDATIONS.....	325
10.1 Conclusions.....	325
10.2 Contribution to knowledge and beneficiaries	336
10.3 Recommendations for further research	337

LIST OF TABLES

Table 1.1 Global Investments in Infrastructure (2016)	2
Table 1.2: Infrastructure investments by Australian States, 2012-2018 (AU\$b)	3
Table 1.3 Data Sources utilised by each specific objective	13
Table 2.1: Infrastructure spending as share of GGE, 2005-2020	23
Table 2.2: Total public and private spending, 1960 to 2017 (%GDP)	32
Table 2.3: Results of normality and transformation - IOI	40
Table 2.4: Correlation coefficients for GDP and the IOI	41
Table 2.5: Linkages of IOI with the Australian economy (GDP).....	42
Table 2.6: Linkages of infrastructure investments among IOI.....	43
Table 2.7: Cross-relationship of investing in IOI	45
Table 3.1: Coal production in Australia in the late-1880 (tons).....	54
Table 3.2: Profile summary of infrastructure linkages evolution in Australia 1788-2017	87
Table 4.1 Salient points of the existing major empirical methodologies.....	90
Table 4.2: IeIOT and its fifteen disaggregated sectors	103
Table 4.3 Linkage dimension estimated by IeIOM	107
Table 4.4: Multiplier types and effects estimated by IeIOM.....	107
Table 4.5: Elasticities estimated by IeIOM	107
Table 4.6: IO structure of Four-Quadrant Linkages Analytic Framework	120
Table 4.7: Cumulative coefficients formulation for each IO quadrant.....	121
Table 4.8: Coefficients sensitivity classes and sensitivity limits.....	122
Table 4.9: Formulation of multiplier effects by multiplier type	129
Table 5.1: Backward Linkages: direction of applying weights	148
Table 5.2: Forward Linkages: direction of applying weights.....	149
Table 5.3: Interpretation of Comparable Coefficient of Variation (C-COV).....	156
Table 5.4: WC-COV formulation summary by directional weighting models.....	159
Table 5.5: Sectoral weight, existing and reformulated methods, 2008-09	161
Table 5.6: Weighted linkage indices, existing and reformulated methods, 2008-09.....	163
Table 5.7: Comparison of existing and proposed indices of variation, 2008-09	164
Table 5.8: Australian key sectors, existing and proposed formulations, 2008-09.....	165
Table 6.1: Five-yearly sectoral pattern of the number of MICs, 1975-2015	175
Table 6.2: Backward MICs (COL-MIC), 2008-09	178
Table 6.3: Forward MICs (ROW-MIC), 2008-09	179
Table 6.4: Backward MIC (COL-MIC), 2014-15.....	180
Table 6.5: Forward MIC (ROW-MIC), 2014-15.....	181
Table 6.6: Stability of important coefficients, 1975 - 2015.....	183
Table 6.7: Forward linkages stability of the natural gas sector (S04), 1975-2015	185
Table 6.8: All sectors average entropy indices status, 1975 to 2015	191
Table 6.9: IOI sectors entropy indices trends, 1975 to 2015	192
Table 7.1: Comparison of linkage methods, impacts on key sector analysis, 2008-09	200
Table 7.2: Inter-Industry Overall Direct Linkage Indices for IOI, 1975 to 2015	201
Table 7.3: IOI inter-industry un-weighted average total linkages, 1975-2015.....	204
Table 7.4: Overall-average unweighted total linkage, other sectors, 1975-2015	205
Table 7.5: Percentage share of un-weighted inter-industry linkages, 2008-09	209

Table 7.6: Highest contributors to un-weighted total backward linkages, 2008-09	209
Table 7.7: Highest contributors to un-weighted total forward linkages, 2008-09	211
Table 7.8: Highest contributors to un-weighted linkages (selected sectors), 1975-2015	211
Table 7.9: Changing patterns of highest contributors to Gas Sector linkages, 1975-2015	212
Table 7.10: Changing patterns of highest contributors to Elect. Gen. by Gas linkages, 1975-2015	212
Table 7.11: Weighted overall-average BL and FL linkages, 1975-2015	213
Table 7.12: Top 10 highest contributors to weighted BL (RSOW method), 2008-09	219
Table 7.13: Top 10 highest contributors to weighted BL (TSOW method), 2008-09	219
Table 7.14: Top 10 highest contributors to weighted FL (RSOW method), 2008-09	219
Table 7.15: Top 10 highest contributors to weighted FL (TSOW method), 2008-09.....	219
Table 7.16: Pattern of change, top contributors to Natural Gas linkages (RSOW), 1975-2015	221
Table 7.17: Changing pattern of top contributor to weighted linkages, 1975-2015	221
Table 7.18: Impacts of linkages analysis methods and time on indices results	222
Table 7.19: Impacts of linkage analysis methods on identification of top contributors, 2008-09	223
Table 7.20: Gas (S02) Sector's complete set of backward linkages, 1975-2015	224
Table 7.21: Gas (S02) Sector's complete set of overall forward linkages, 1975-2015.....	227
Table 7.22: Primary factors overall-average total backward indices for IOI, 1975-2015.....	228
Table 7.23: Final demand un-weighted average total forward linkages, IOI, 1975-2015	230
Table 7.24: Primary factors and final demand total linkages, IOI, 1975-2015.....	233
Table 7.25: Overall-average purchases of primary factors by final demand, 1975-2015	235
Table 7.26: The proposed sectoral classification assessment	236
Table 7.27: Results of proposed un-weighted sectoral classification system (incorporating C-COV), 1975 to 2015	239
Table 7.28: Results of proposed integrated un-weighted and weighted sectoral classification method (incorporating RSOW and C-COV), 1975 to 2015.....	240
Table 8.1: Output multipliers, 2014-15 (AU\$m)	248
Table 8.2: Electricity sectors, output multipliers, 1975-2015	250
Table 8.3: Electricity sectors, output multiplier effects, 1975-2015	250
Table 8.4: High ranking type II overall average output multipliers, 2009 to 2015.....	252
Table 8.5: High ranking type I overall average output multipliers, 2009 to 2015	252
Table 8.6: Induced output multipliers ¹ , 1975-2015 (Indexed, 1975=100).....	256
Table 8.7: Employment multipliers, 2014-15	257
Table 8.8: Income multipliers, 2014-15 (AU\$m)	261
Table 8.9: Indirect income multipliers, 1975 to 2015 (indexed, 1975=100)	264
Table 8.10: Overall induced income multipliers, 1975-2015	266
Table 8.11: VA multipliers and IOFQLAF linkages, 2008-09 & 2014-15 (AU\$m)	267
Table 8.12: Value added multipliers, 2014-15 (AU\$m)	268
Table 8.13: Top 15 sectors with the highest multipliers, 2014-15.....	269
Table 8.14: Output multipliers translated into socio-economic types, 2014-15	272
Table 8.15: Elasticity of sectoral supply, 1975 - 2015.....	275
Table 8.16: Final Demand - Value Added elasticities by sector, 1975-2015.....	278
Table 8.17: Sectors with both supply and value added inelasticities, 1975-2015.....	281
Table 8.18: Final demand IO summary table for Australia, 2008-09 (AU\$m).....	284
Table 8.19: Direct industrial activity summary, 2008-09 (AU\$m).....	284

Table 8.20: Final demand IO summary table for Australia, 2014-14 (AU\$m)	285
Table 8.21: Direct industrial activity summary, 2014-15 (AU\$m)	285
Table 8.22: Base sectors in Australian economy, 2014-15	286
Table 9.1: Scenarios Trends/Assumptions, 2015-2050 (%)	293
Table 9.2: Australian and global future of eVehicles uptake, 2030 to 2050	295
Table 9.3: Net trade in energy, Base Case growth, 2015 to 2050	296
Table 9.4: Backward linkages, 2015 - 2050	299
Table 9.5: Backward linkages, %Change (2035, 2050)	300
Table 9.6: Summary %change, backward linkage by scenarios, 2015 to 2050	304
Table 9.7: Summary inter-scenario %change, backward linkages, 2035 and 2050	306
Table 9.8: Electricity Requirements of Transport Sector, 2015-2050	306
Table 9.9: Forward linkages, 2015 – 2050 (% change)	308
Table 9.10: Forward linkages, 2035, 2050 (% change)	309
Table 9.11: Natural Gas forward linkages with inter-industry sectors, 2015-50	311
Table 9.12: Gas forward linkages with sectors of final demand, 2015-50	311
Table 9.13: Impact of change in Gas forward linkage in economy, 2015-2050	312
Table 9.14: Change in forward linkages of Petroleum Prod. Mfg, 2015 to 2050	312
Table 9.15: Supply of electricity to the transport sector, 2015 to 2050	313
Table 9.16: Forward linkages, intra and inter-scenario comparison, 2015-20150	314
Table 9.17: Forward linkages, inter-scenario analysis, 2035 and 2050	315
Table 9.18: Scenarios impacts on the Australian economy, 2015 – 2050	322

LIST OF FIGURES

Figure 1.1: Infrastructure investment needs by world regions, 2016-2040 (\$b).....	4
Figure 1.2: Total infrastructure investment, need and gap by world regions, 2016-2040 (\$t).....	4
Figure 1.3: The Research methodological framework.....	9
Figure 1.4: Historical profile timeline of prominent events, 1788 to 2017.....	10
Figure 2.1: Total fixed capital infrastructure investment, developed countries, 1990-2004.....	21
Figure 2.2: Public infrastructure spending in developed countries, 1990-2004.....	21
Figure 2.3: Global Infrastructure FDI inflows, 1980-2007 (\$b)	21
Figure 2.4: Australia's public infrastructure spending, global comparison: 2004-2014.....	23
Figure 2.5: Total infrastructure capital stock, selected developed countries (% of GDP, 2000 purchasing power parity, \$US)	25
Figure 2.6: Net public infrastructure capital stock, selected developed countries (% of GDP, 2000 purchasing power parity, \$US)	25
Figure 2.7: Australia's total infrastructure stock of built assets, 2012-2014 (\$US trillion).....	27
Figure 2.8: Australia's global position - infrastructure assets per capita, 2014 (US\$)	27
Figure 2.9: Infrastructure with the highest public spending, 1998 – 2017 (% of GDP, Real Term, 2015-16=100.0).....	28
Figure 2.10: Infrastructure with the lowest public spending, 1998-2017 (% of GDP, Real Term, 2015-16=100.0).....	28
Figure 2.11: Total public infrastructure spending, 1960-2017 (\$m, and % of GDP)	29
Figure 2.12: Australia's public infrastructure spending, 2015 to 2017.....	30
Figure 2.13: Australia's recession free consecutive quarters, 3Q-1991 to 2Q-2016	30
Figure 2.14: Infrastructure with the highest private spending, 1998-2017 (% of GDP, Real Term, 2015-16=100.0).....	31
Figure 2.15: Infrastructure with the least private spending, 1998-2017 (% of GDP, Real Term, 2006-07=100.00).....	31
Figure 2.16: Private sector's pattern in infrastructure spending, 1960 to 2017	32
Figure 2.17: Total infrastructure spending (Public and private) 1960-2017 (% of GDP, Real Term, 2015-16=100).....	33
Figure 2.18: Investments in resources and non-resources infrastructure, 1998-2017 (% of GDP, Real Term, 2015-16=100.0).....	34
Figure 3.1: Infrastructure linkages, the historical analysis framework.....	48
Figure 4.1: Infrastructure-embedded IO model (IeIOM), a schematic representation.....	102
Figure 4.2: The ieiom dynamic data inputs model and databases.....	104
Figure 4.3: Infrastructure linkages: a schematic overview	113
Figure 4.4: Linkages of crude oil as a reference sector with other sectors	114
Figure 4.5: Multipliers as the system of interlinked transactions in the economy	126
Figure 4.6: Multipliers effects in the economy, a schematic representation.....	127
Figure 5.1: Alternative dimensional-direction-of-weighting io coefficients	150
Figure 6.1: Value added trends, for IOI: 1975-2015 (absolute terms).....	170
Figure 6.2: Changes in relative contribution to GVA (Resource-IOI), 1975-2015	170
Figure 6.3: Changes in relative contribution to GVA (electricity), 1975-2015	171
Figure 6.4: Changes in relative contribution to GVA (water), 1975-2015	171
Figure 6.5: Changes in relative contribution to GVA (major sectors), 1975-2015.....	171
Figure 6.6: Changes in relative contribution to GVA (services sectors), 1975-2015	171

Figure 6.7: Increasing pattern of competing imports, for IOI, 1975-2015	171
Figure 6.8: Changes in relative contribution to GVA (electricity generation by other fuels), 1975-2015.....	171
Figure 6.9: Stability of economy's MICs, 1975-2015.....	182
Figure 6.10: Stability of BL-MICs by IOI Sectors, 1975-2015.....	182
Figure 6.11: Natural GAS FL-MICs, 1975-2015	184
Figure 6.12: Elect. Gen. by Gas FL-MICs, 1975-2015	184
Figure 6.13: Average backward and forward concentration indices, 1975-2015.....	187
Figure 6.14: Concentration indices (Elect. Gen. by renewables), 1975-2015	188
Figure 6.15: concentration indices (Coal), 1975-2015	188
Figure 6.16: Concentration indices (Elect. T&D), 1975-2015	188
Figure 6.17: Concentration indices (Water Services), 1975-2015.....	188
Figure 6.18: Average entropy indices, 1975-2015	190
Figure 6.19: Entropy indices (Coal), 1975-2015	192
Figure 6.20: Entropy indices (Other Mining), 1975-2015.....	192
Figure 6.21: Entropy indices (Elec. T&D), 1975-2015.....	192
Figure 6.22: Entropy indices (Urb Water), 1975-2015.....	192
Figure 7.1: Linkage components by IO Four-Quadrant Framework	198
Figure 7.2: Unweighted total linkage indices, Coal Mining, 1975-2015	205
Figure 7.3: Unweighted total linkage indices, Crude Oil, 1975-2015	205
Figure 7.4: Unweighted total inter-industry linkages, 2008-09.....	207
Figure 7.5: Weighted total linkages for all sectors (RSOW method), 2008-09.....	215
Figure 7.6: Weighted total linkages for all sectors (TSOW method), 2008-09.....	216
Figure 7.7: IOI Weighted total linkages (Traditional SOW method), 2008-09.....	217
Figure 7.8: IOI weighted total linkages (Reformulated SOW method), 2008-09	217
Figure 7.9: Weighted total linkages (RSOW), Coal Mining, 1975-2015.....	217
Figure 7.10: Weighted total linkages (TSOW), Coal Mining, 1975-2015	217
Figure 7.11: Weighted total linkages (RSOW), Crude Oil, 1975-2015	217
Figure 7.12: Weighted total linkages (TSOW), Crude Oil, 1975-2015.....	217
Figure 7.13: Un-weighted total and grand total backward linkages, Gas (S04) Sector, 1975-2015.....	225
Figure 7.14: Final demand un-weighted total forward linkages, Gas Sector (S04), 1975-2015.....	231
Figure 7.15: Un-weighted primary factors total BL and ranks, Gas (S04), 1975-2015	232
Figure 7.16: Un-weighted final demand total FL and ranks, Gas (S04), 1975-2015	232
Figure 7.17: Unweighted total direct hire of labour by final demand sectors, 1975-2015	234
Figure 7.18: Direct purchases of primary factors by sectors of final demand, 1975-2015.....	235
Figure 7.19: The process-flow of proposed sectoral classification system	237
Figure 8.1: Indirect output multiplier, Electricity Sector, 1975-2015 (Index, 1975=100)	252
Figure 8.2: Indirect output multipliers, Energy and Services Sectors, 1975-2015 (Index, 1975=100).....	252
Figure 8.3: Indirect output multipliers, Water Sectors (Index, 1975=100)	253
Figure 8.4: Indirect output multipliers, Major Sectors, 1975-2015 (Index, 1975=100).....	253
Figure 8.5: Induced output multiplier, Electricity Sector, 1975-2015 (Index, 1975=100).....	255
Figure 8.6: Induced output multipliers, Other Energy Sectors, 1975-2015 (Index, 1975=100).....	255
Figure 8.7: Induced output multipliers, Water Supply and Services (Index, 1975=100).....	255

Figure 8.8: Induced output multipliers, Other Major Sectors, 1975-2015 (Index, 1975=100) .	255
Figure 8.9: Employment multipliers, 2014-15	258
Figure 8.10: Indirect employment multipliers, electricity sector, 1975-2015 (Index, 1975=100).....	259
Figure 8.11: Indirect employment multipliers, Other Energy Sectors, 1975-2015 (Index, 1975=100).....	259
Figure 8.12: Indirect employment multipliers, Water Sector, 1975-2015 (Index, 1975=100)	260
Figure 8.13: Indirect income multipliers, Electricity Sector, 1975-2015 (Index, 1975=100)...	262
Figure 8.14: Indirect income multipliers, Other Energy Sectors, 1975-2015 (Index, 1975=100).....	262
Figure 8.15: Indirect income multipliers, Water Sector, 1975-2015 (Index, 1975=100)	262
Figure 8.16: Indirect income multipliers, Other Sectors, 1975-2015 (Index, 1975=100).....	262
Figure 8.17: Induced income multipliers, Electricity Sector, 1975-2015 (Index, 1975=100) ..	265
Figure 8.18: Induced income multipliers, Other Energy Sectors, 1975-2015 (Index, 1975=100).....	265
Figure 8.19: Induced Income Multipliers, Water Sector, 1975-2015 (Index, 1975=100)	265
Figure 8.20: Induced Income Multipliers, Major Sectors, 1975-2015 (Index, 1975=100).....	265
Figure 8.21: Indirect value added multipliers, Electricity Sector, 1975-2015 (Index, 1975=100).....	270
Figure 8.22: Indirect value added multipliers, Other Energy, 1975-2015 (Index, 1975=100) ..	270
Figure 8.23: Indirect value added multipliers trends, Electricity Sector, 1975-2015 (Index, 1975=100).....	270
Figure 8.24: Indirect value added multipliers trends, Other Energy Sectors, 1975-2015 (Index, 1975=100).....	270
Figure 8.25: Indirect value added multipliers, Water Sector, 1975-2015 (Index, 1975=100) ..	270
Figure 8.26: Indirect value added multipliers, Major Sectors, 1975-2015 (Index, 1975=100).	270
Figure 8.27: Elasticity of Sectoral Supply, sectoral status, 1975 to 2015	276
Figure 8.28: Overall sectoral elasticity of Final Demand-Value Added Response, 1975-2015	280
Figure 9.1: Pattern of adopting eVehicles in Australia, 2011-2016.....	294
Figure 9.2: Australia's future gas export to 2027	297
Figure 9.3: Change in electricity sectors' backward linkages, 2015-2050	303
Figure 9.4: Sectoral status in Base Case, 2015	318
Figure 9.5: Sectoral status in Base Case, 2035	318
Figure 9.6: Sectoral status in Base Case, 2050	318
Figure 9.7: Renewable-Supreme sectoral status, 2035	319
Figure 9.8: Renewable-Supreme sectoral status, 2050	319
Figure 9.9: Exports-Dominant sectoral status, 2035	320
Figure 9.10: Exports-Dominant sectoral status, 2050	320

LIST OF ABBREVIATIONS AND ACRONYMS

ABARE	Australian Bureau of Agricultural and Resource
ABIX	Australian Business Intelligence
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ACT	Australian Capital Territory
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
ANAO	Australian National Audit Office
ANZSIC	Australian and New Zealand Standard Industrial Classification
APGA	Australian Pipelines and Gas Association
APPEA	Australian Petroleum Production & Exploration Association
ARCADIS	A global design, engineering and management consulting company
ASIOT	Alternative Scenario Input-Output Table
ATIC	Australian Trade and Investment Commission
AU	Australia
AUD	Australian Dollar
AWRC	Australian Water Resource Commission
BC	Base Case
BCA	Business Council of Australia
Bcf	Billion cubic feet
BCSIOT	Base Case Scenario Input-Output Table
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BL	Backward Linkages
BL-CI	Backward Linkages Concentration Indices
BL-H2	Highest Contributor to Backward Linkages
BL-I	Backward Linkages Important Coefficients
BL-LI	Backward Linkages Less Important Coefficients
BL-MIC	Backward Linkages Most Important Coefficients
BL-PF	Backward Linkages Primary Factors
BREE	Bureau of Resource and Energy Economics
C-COV	Comparable Coefficient of Variance
CEDA	Committee for Economic Development Australia
CGE	Computational General Equilibrium
CL	Complementary Linkages
COAG	Council of Australian Governments
Col-MIC	Backward Linkages Most Important Coefficients
COM	Coal-to-Oil
ComLAW	Federal Register of Legislation
COV	Coefficient of Variation
CPI	Consumer Price Index
CPM	Carbon Pricing Mechanism
CSG	Coal Seam Gas

CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSM	Coal Seam Gas
CTL	Coal-to-Liquid
CTRE	Centre for Transportation Research and Education
CW	Chenery-Watanabe
CWA	Climate Works Australia
DEA	Data Envelop Analysis
DEE	Department of Energy and Environment
DFAT	Department of Foreign Affairs and Trade
DGI	Data Gaps Initiative
DIIS	Department of Industry, Innovation and Science
DIRD	Department of Infrastructure and Regional Development
DITR	Department of Industry Tourism and Resources
DNRM	Department of Natural Resources and Mines
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
ED	Exports-Dominant
EIA	Energy Information Administration
ENA	Energy Network Australia
EPA	Environment Protection Authority
Eq.	Equation
ESAA	Energy Supply Association of Australia
ESOW	Equally-Weighted System of Weights
ESSR	Elasticity of Sectoral Supply Response
EU	European Union
FC	Financial Crisis
FDI	Foreign Direct Investment
FDI	Foreign Direct Investment
FD-VA	Final Demand - Value Added
FL	Forward Linkages
FL-CI	Forward Linkages Concentration Indices
FL-H2	Highest Contributor to Forward Linkages
FL-I	Forward Linkages Important Coefficients
FL-LI	Forward Linkages Less Important Coefficients
FL-MIC	Forward Linkages Most Important Coefficients
FRC	Full Retail Contestability
FTE	Full Time Equivalent
G-20 (G20)	Group of Twenty
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GGAS	Greenhouse Gas Abatement Scheme
GGE	General Government Expenditure
GIIA	Global Infrastructure Investor Association

GSP	Gross State Product
GST	Good and Services Tax
GTAP	Global Trade Association Project
GVA	Gross Value Added
H1	Intra-Industry Trade Linkages
H2 to H6	Highest to Lowest Contributors to Linkage Magnitudes
HD	Harrod-Domar
HEM	Hypothetical Extraction Method
I	Important Coefficients
IA	Infrastructure Australia
IAQ	Industry Association of Queensland
IBRD	International Bank for Reconstruction and Development
IC	Industry Commission
ICA	Institute of Chartered Accountant
ICOR	Incremental Capital Output Ratio
IDA	International Development Association
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IeIOM	Infrastructure-embedded Input-Output Model
IeIOT	Infrastructure0Embedded Input-Output Table
IFC	International Finance Corporation
IFGW	Infrastructure Finance Working Group
IMD	Institute of Management Development
IMF	International Monetary Fund
IMPLAN	IMpact analysis for PLANning
IO	Input-Output
IOFQLAF	Input-Output Four-Quadrant Linkages Analysis Framework
IOI	Infrastructure of Interest
IOT	Input-Output Table
IPA	Infrastructure Partnerships Australia
IPART	Independent Pricing and Regulatory Tribunal
LCA	Life Cycle Assessment
LCD	Least Developed Countries
LI	Less Important Coefficients
LNG	Liquefied Natural Gas
LPG	Liquid Petroleum Gas
LQ	Location Quotient
LSES	Linkage Strength Evaluation Score
MCE	Ministerial Council of Energy
MENA	Middle East and North Africa
MF	Market Forces
MIC	Most Important Coefficients

MRET	Mandatory Renewable Energy Target
MRVIO	Multiregional Variable Input-Output
MRW	Mankiw-Romer-Weil
NCC	National Competition Council
NCP	National Competition Policy
NEG	National Energy Guarantee Scheme
NEM	National Electricity Market
NETS	National Emission Trading Scheme
NI	Not Important Coefficients
NLECC	National Low Emission Clean Coal Council
NSW	New South Wales
NSWDPI	NSW Department of Primary Industry
NSWEPA	NSW Environment Protection Authority
NT	Northern Territory
NT	Net Trade
NTC	National Transport Commission
NWC	National Water Commission
NWI	National Water Initiative
NWIDF	National Water Infrastructure Development Fund
NWRC	NSW Water Resource Commission
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PC	Productivity Commission
PEIM	Preservation Economic Impact Model
PF	Primary Factors
PF-FD	Final Demand Direct Purchases of Primary Factors
PIM	Perpetual Inventory Method
PNG	Papua New Guinea
PPI	Producer Price Index
PRRT	Petroleum Resource Rent Tax
Pub	Public
PV	Photovoltaic
Pvt	Private
PwC	PiecewaterhouseCoopers
Q1	Quadrant One
Q2	Quadrant Two
Q3	Quadrant Three
Q4	Quadrant Four
QLD	Queensland
R&D	Research and Development
R1	Recession 1, 1975

R2	Recession 2, 1977
R3	Recession 3, 1981-83
R4	Recession 4, 1990-91
RAS	Rows and Sums
REDM	Relative Employment Density Model
REMI	Regional Economic Models, Inc.
RET	Renewable Energy Target
RIMS	Regional Input-Output Modelling System
ROW-MIC	Forward Linkages Most Important Coefficients
RRT	Resource Rent Tax
RS	Renewable-Supreme
RST	Rest of the Sectors
S01	Sector Number One
SA	South Australia
SAM	Social Accounting Matrix
SME	Subject Matter Experts
SPIM	Simplified Perpetual Inventory Method
SSC	System of Sectoral Classification
T&D	Transmission and Distribution
TFP	Total Factor Productivity
TSOW	Traditional System of Weights
UBER	Utah Economic and Business Review
UCG	Underground Coal Gasification
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
US	United States
VIC	Victoria
VIO	Variable Input-Output
WA	Western Australia
WC-COV	Weighted Comparable Coefficient of Variance
WCI	World Coal Institute
WEF	World Economic Forum
WSAA	Water Services Association of Australia
WSOW	Weighted System of Weights
WSUD	Water Sensitive Urban Design
WW-I	World War One
WW-II	World War Two
\$b	Dollars in Billions
\$m	Dollars in Millions
\$t	Dollars in Trillions

LIST OF APPENDICES

APPENDIX I: The infrastructure needs and investment gaps by country over the period 2016 to 2040	343
APPENDIX II: Philosophy of infrastructure investment in Australia, and FDI.....	345
APPENDIX III: Highlights of the early coal infrastructure in Australia.....	351
APPENDIX IV: Sectors and IOIG mapping details and IO tables structure	353
APPENDIX V: Derivation of Weighted Comparable Coefficient of Variation and Justification of Leontief-Ghosh Framework.....	365
APPENDIX VI: Full set of imports and associated ranks; and MIC, Concentration, Entropy indices, 1975 2015.....	373
APPENDIX VII: Full set of IO linkages in each quadrant, and key sector identification approaches	397
APPENDIX VIII: Detailed tables of multiplier and elasticity indices, 1975-2015.....	441
BIBLIOGRAPHY:	465
PART A: References cited in this thesis	467
PART B: References consulted but not cited in this thesis	501

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ABSTRACT

In view of the widely-recognised importance of infrastructure in promoting socio-economic prosperity, and prompted by the shallowness of our current understanding of the inter-infrastructure, and infrastructure-economy, linkages and (hence) their policy-usefulness - this research develops a comprehensive analyses of such linkages in the Australian context. For this purpose, this research has developed an integrated framework comprising two complementary models, namely, an empiric-analytic model and an Infrastructure-embedded Input-Output Model (IeIOM). Further, this research has analysed linkages, over the period 1975-2015, for 39 major sectors of the Australian economy, including 19 infrastructure sectors. The consequences of National Energy Guarantee Scheme (a major initiative of the Australian government) on the evolution of linkages, to the year 2050, are also analysed. The analyses suggest that the evolutionary trajectory of infrastructure-economy linkages has indeed been shaped by a complex web of interlocked influences whose internal and external logic resides in the economic, socio-cultural and political domains of the nation. The IeIOM has provided quantitative substantiation for these findings, and has established their policy connects. Some of the key findings of this research are that: 1) key sectors of the economy, i.e., sectors with most extended forward and backward linkages are electricity generation, transmission and distribution; gas supply; iron and steel; non-metallic and mineral products; wood products; and agriculture; 2) major sectors in terms of significant forward linkages include a combination of economic (mineral mining, coal, basic-non-ferrous metals, machinery, transport, and construction) and social (households, education, health, etc.) infrastructure; 3) 22 sectors (most notably, gas supply, electricity generation from natural gas, petroleum products, paper manufacturing, food, electricity transmission and distribution, and coal) exhibit highly inelastic sectoral supply and value added responses, thus presenting high risks for downstream production sectors; 4) highly profitable petroleum producing sector does not significantly contribute to value-added, because of its heavy reliance on imported inputs; 5) trends towards increased exports of natural gas, as compared with its use for domestic purposes, is likely to be detrimental to the economic well-being of the nation; and 6) National Energy Guarantee Scheme is unlikely to extend the reach of linkages, thus limiting its usefulness in the broader economic context. These (and other) insights of this research, through their elucidation of key policy-tradeoffs, and – more importantly – through their questioning of preconceived notions about infrastructure-economy linkages, should constitute useful bases for infrastructure policy development – an issue of utmost contemporary significance – as nations around the world endeavour to devise policies for provisioning infrastructure of the future, in the backdrop of rapidly transforming global technological, economic and social landscapes.

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